



Australian Government

Australian Centre for
International Agricultural Research

SMALLHOLDER COFFEE PRODUCTION IN
PAPUA NEW GUINEA – FARMER TRAINING GUIDE

UNIT 1: BECOMING A COFFEE FARMER

MODULE 1: KNOWING YOUR COFFEE TREE



Curry G, Tilden G, and Aroga L (2023)
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1571, Canberra ACT 2601, aciarc@aciarc.gov.au

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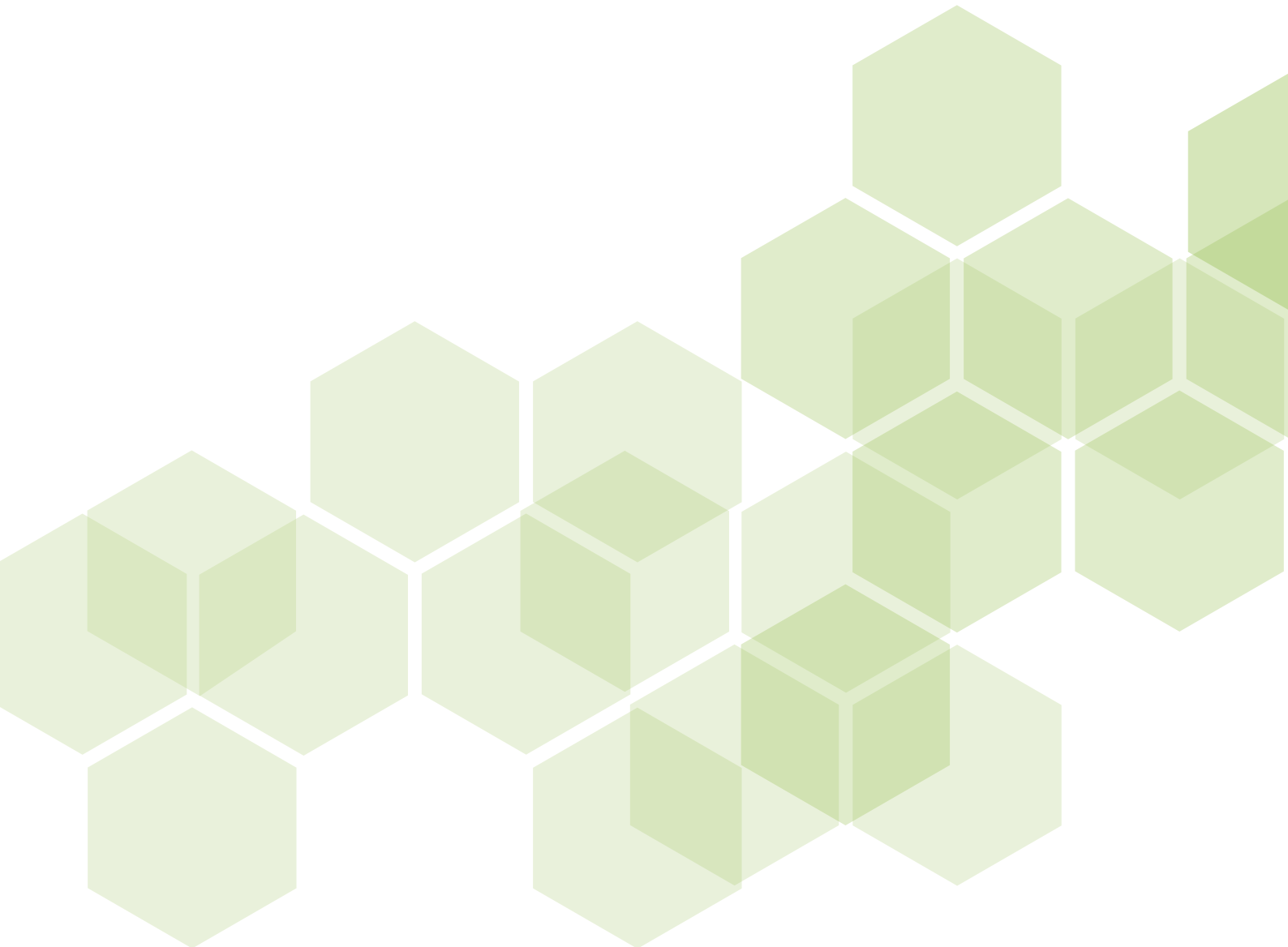
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International Agricultural Research**

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UNIT 1: BECOMING A COFFEE FARMER

MODULE 1:

KNOWING YOUR COFFEE TREE



The Smallholder Coffee Production in Papua New Guinea Training Program

The training program contains modules prepared in partnership with Australian Centre for International Agricultural Research (ACIAR) and by CARE-International.

The structures of the Extension Officer Training Program and the Farmer Training Program are shown in the table below.

Some modules also contain references to additional training that learners are encouraged to complete as part of their training.

ACIAR Resource

Monograph MN220 Smallholder Coffee Production in Papua New Guinea: a training package for extension officers and farmers. This package contains the modules for both the extension officer training guide and the farmer training guide. The ACIAR monograph is available online from www.aciar.gov.au

Hard copies of the ACIAR training package may be available by contacting ACIAR or the Coffee Industry Corporation (CIC)

CARE Resources

Organisational Strengthening Training
CARE Family Money Management Training

The CARE modules are available online from <https://pngcdwstandard.com/resources-for-use-by-cdws-working-with-wards-communities-groups-and-smes>

Hard copies of the CARE modules may be available by contacting the CIC or CARE-International.

Extension Officer Training Program

Title	Module reference
Introduction to smallholder coffee production in Papua New Guinea	ACIAR Smallholder Coffee Production in Papua New Guinea Training Package
Extension Principles	
Introduction to the Coffee Extension Officer and Farmer Training Guides	ACIAR Extension Officer Training Guide Unit 1 Module 1
The extension officer - roles and effectiveness	ACIAR Extension Officer Training Guide Unit 1 Module 2
Knowing Your Farmers	
Getting to know our coffee smallholders	ACIAR Extension Officer Training Guide Unit 2 Module 1
What factors affect smallholder coffee production?	ACIAR Extension Officer Training Guide Unit 2 Module 2
Strongim grup: course facilitator guide	CARE Organisational Strengthening Training

Farmer Training Program

Title	Module reference
Becoming a Coffee Farmer	
Knowing your coffee tree	ACIAR Farmer Training Guide Unit 1 Module 1
Coffee nursery development	ACIAR Farmer Training Guide Unit 1 Module 2
Establishing a new coffee garden	ACIAR Farmer Training Guide Unit 1 Module 3
Managing Your Coffee Garden	
Weed control	ACIAR Farmer Training Guide Unit 2 Module 1
Maintenance pruning and rehabilitation	ACIAR Farmer Training Guide Unit 2 Module 2
Shade management	ACIAR Farmer Training Guide Unit 2 Module 3
Drainage	ACIAR Farmer Training Guide Unit 2 Module 4
Pest and disease management	ACIAR Farmer Training Guide Unit 2 Module 5
Coffee berry borer management	ACIAR Farmer Training Guide Unit 2 Module 6
Soil fertility and nutrient maintenance	ACIAR Farmer Training Guide Unit 2 Module 7
Intercropping in your coffee garden	ACIAR Farmer Training Guide Unit 2 Module 8
Harvesting and Processing Coffee	
Coffee harvesting and processing	ACIAR Farmer Training Guide Unit 3 Module 1
Coffee grading systems and pricing	ACIAR Farmer Training Guide Unit 3 Module 2
Establishing a mini wet factory	ACIAR Farmer Training Guide Unit 3 Module 3
Coffee Marketing	
Understanding the domestic coffee market	ACIAR Farmer Training Guide Unit 4 Module 1
Kamapim ol prairiti	CARE Organisational Strengthening Training
Kamapim ol eksen plen	CARE Organisational Strengthening Training
Setim gutpela kastom bilong ronim grup	CARE Organisational Strengthening Training
Wok bilong meneja na memba na lida	CARE Organisational Strengthening Training
Coffee certification	ACIAR Farmer Training Guide Unit 4 Module 2
Fairtrade certification	ACIAR Farmer Training Guide Unit 4 Module 3
Family money management	CARE Family Money Management Training

CONTENTS

CONTRIBUTING AUTHORS	3
ACKNOWLEDGEMENTS	3
INTRODUCTION	4
Aim	4
Learning outcomes	4
Lesson plan	4
List of symbols	5
Teaching aids	5
Pre-training activities	5
Preliminary activities	6

MODULE TOPICS

1.1 SPREAD OF COFFEE GLOBALLY AND IN PNG	7
Coffee globally	7
Coffee in PNG	9
1.2 COFFEE VARIETIES	11
Commercial coffee varieties in PNG	11
Some factors to consider when choosing coffee varieties	12
Exercise 1: Coffee varieties	14
1.3 STRUCTURE OF THE COFFEE TREE	15
Why is it important to know about the structure of the coffee tree?	15
The root system	16
Maintaining healthy roots	17
The shoot system	19
Competition and the importance of maintaining a healthy shoot and root system	22
Exercise 2: Parts of a coffee tree	23
Exercise 3: The importance of maintaining healthy roots and shoots	23

1.4	DEVELOPMENT OF COFFEE CHERRY	24
	Flowering to harvest	24
	When to harvest cherry	26
	Parts of the fully developed coffee cherry	28
	Exercise 4: Cherry development	29
	Exercise 5: Parts of the coffee cherry	29
1.5	KEY MESSAGES	30
1.6	QUIZ	31
1.7	SOURCES OF FURTHER INFORMATION	36

CONTRIBUTING AUTHORS

George Curry, Geraldine Tilden, Leo Aroga, Mike Webb, Tom Kukhang and Tim Sharp

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INTRODUCTION

Aim of Module:

The aim of this module is to provide information about coffee and the coffee tree:

1. The main varieties of Arabica coffee
2. Their physical features
3. The environment most suitable for each variety
4. The development of coffee cherry from flowering through to overripe berries

To have a highly productive coffee garden it is important to firstly plant the correct variety of coffee for your circumstances, understand the important functions of each part of the coffee tree and the sequence of events from flowering through to harvest of good quality cherry.

LEARNING OUTCOMES:

By the end of this module you will:

- ✓ Know the history of coffee globally and in PNG
- ✓ Be able to identify the suitability of different varieties of Arabica coffee for PNG's different environments so as to maximise production
- ✓ Understand the structure of a coffee tree and the functions of its root and shoot systems
- ✓ Understand the development of the coffee cherry from flowering through to the ripe cherry

LESSON PLAN:

The module has four parts:

Section 1.1 Spread of coffee globally and in PNG






Section 1.2 Arabica coffee varieties

Section 1.3 Structure of a coffee tree

Section 1.4 Development of coffee cherry

TIME REQUIRED TO COMPLETE THIS MODULE: 3 DAYS

LIST OF SYMBOLS: TEACHING AIDS:

	Additional information for the extension officer
	Information relating to CBB
	Farmer notes, brochures & factsheets
	Information for farmers that must be taken very seriously
	For the Extension Officer

- Farmer notes
- Map of the world showing coffee exporting and importing countries
- Map of PNG showing Arabica coffee production by province
- CIC Coffee varieties poster
- Coffee seedling in a polybag
- A 12 month old coffee tree removed from the ground to show the different parts of the shoot and root systems
- Animation showing the process of photosynthesis
- CIC post-harvest cherry chart (for correct colour of cherry for harvest)
- Poster of coffee bean development from flowering to red cherry ready for harvest
- Access to a coffee garden which has cherries ready for harvesting
- Diagram of a fully developed cherry with no labels
- Identify a coffee tree branch in the coffee garden with progressive colours of berries to point out those that are ready for harvesting
- To demonstrate progression of cherry development, use four bowls of berries at different stages of development/colour from light green through to brown or overripe (light green, yellow-orange, bright red and brown). This is to show the change in colour during development and to illustrate when the cherry is at its highest value. If berries are not available, use the CIC cherry chart which shows the colour of berries at the different stages of development
- Branch of a coffee tree with bright red cherries
- The coffee calendar and stickers
- Video of cherry development on the coffee tree
- Aids for exercises and quiz – butchers' paper and marker pen

PRE-TRAINING ACTIVITIES:

- Arrange with the CIC nursery to have a polybag coffee seedling for use at the time of presentation of the module
- Arrange access to a coffee garden that has mature, bright red cherries. This garden should also have berries that are immature through to overripe that can be used for the cherry development demonstration
- Source and dig up a one year old coffee tree to show shoot and root systems

PRELIMINARY ACTIVITIES

The farmers will complete two exercises prior to undertaking the module topics. These include the coffee calendar and the quiz. The purpose of these exercises is for the extension officer to assess the level of knowledge of farmers in the group prior to completing the module.

The Coffee Calendar

The coffee calendar lists the main activities undertaken during an annual cycle of coffee production. The first item on the calendar is coffee berry development. All other activities are linked to the stage of development of coffee berries from flowering through to overripe cherry.

The annual coffee production cycle

1. Flowering and berry development
2. Harvesting coffee
3. Pulping and drying coffee
4. Maintenance – weeding, pruning, mulching, shade management, digging and maintaining drains, maintaining fencing.
5. CBB control measures
6. Sucker selection
 - Working with the farmer group attach stickers to complete each row of the coffee calendar
 - Begin by attaching the progressive stages of coffee berry development from flowering through to bright red cherry at its highest value, and to overripe cherry
 - Attach a CBB sticker on the cherry development row to indicate where berries can begin to become susceptible to CBB (when the beans begin to form)
 - Complete the remaining sections linking each activity with the different stages of berry development

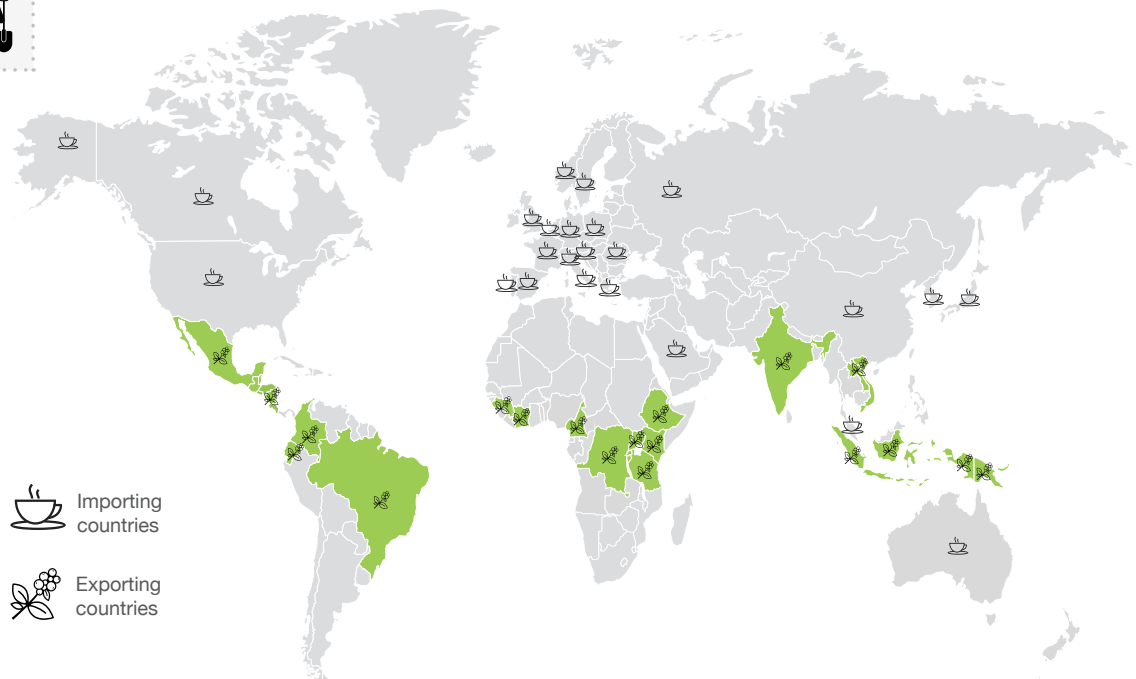
Quiz

Before beginning the module topics, have the farmers complete the quiz at the end of this module. The quiz will then be repeated on completion of the module topics.

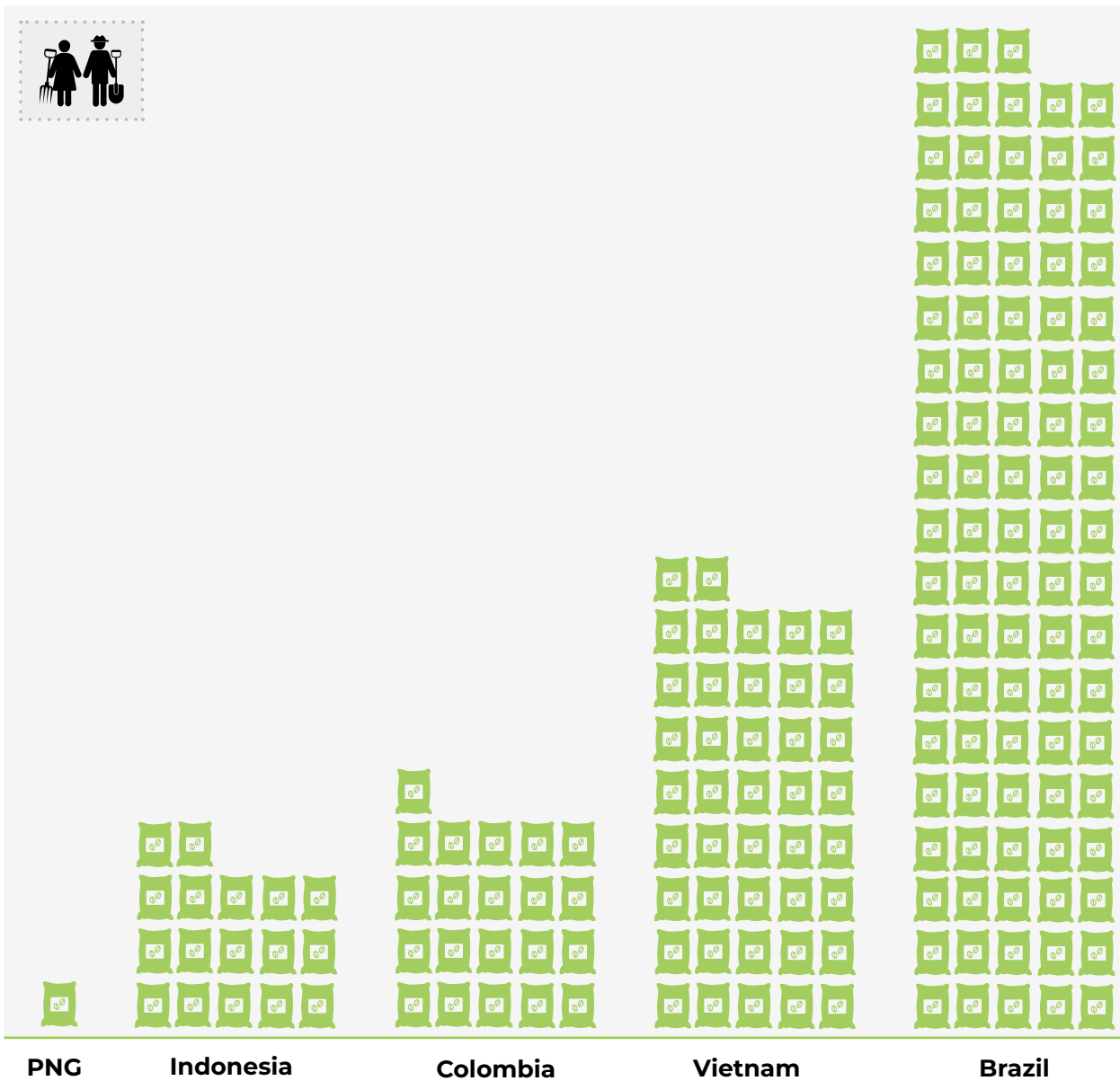
1.1 SPREAD OF COFFEE GLOBALLY AND IN PNG

Coffee globally

- Coffee has been consumed worldwide for hundreds of years
- It originates from Ethiopia but the cultivation and trade of coffee first began in Arabia in the 1400s
- Traders introduced it into Europe in the 1600s, then European nations established coffee plantations in their colonies in the tropics including in South America, Africa, Asia and the Pacific
- International trade saw demand for coffee increase around the world. It is now one of the world's most traded commodities and engages over 100 million people in all aspects of its production
- Coffee is a primary export commodity and earner of foreign exchange for many countries
- World production in 2020 was 170 million (60 kg) bags of green bean, or 10 million tonnes. Brazil is the largest producer followed by Vietnam, Colombia and Indonesia
- World stocks of coffee fluctuate due to unpredictable supply. This is due to extremes of weather such as frost or outbreaks of diseases such as Coffee Leaf Rust (CLR)
- In 2020, PNG was the 17th largest producer, producing 683,000 bags or 41,000 tonnes of green bean. This is less than 1% of the world's production



The main coffee exporting and importing countries



The number of bags of green bean the 4 top coffee producing countries produce to every single bag produced by PNG (ICO, 2020 coffee year production).

Some key points

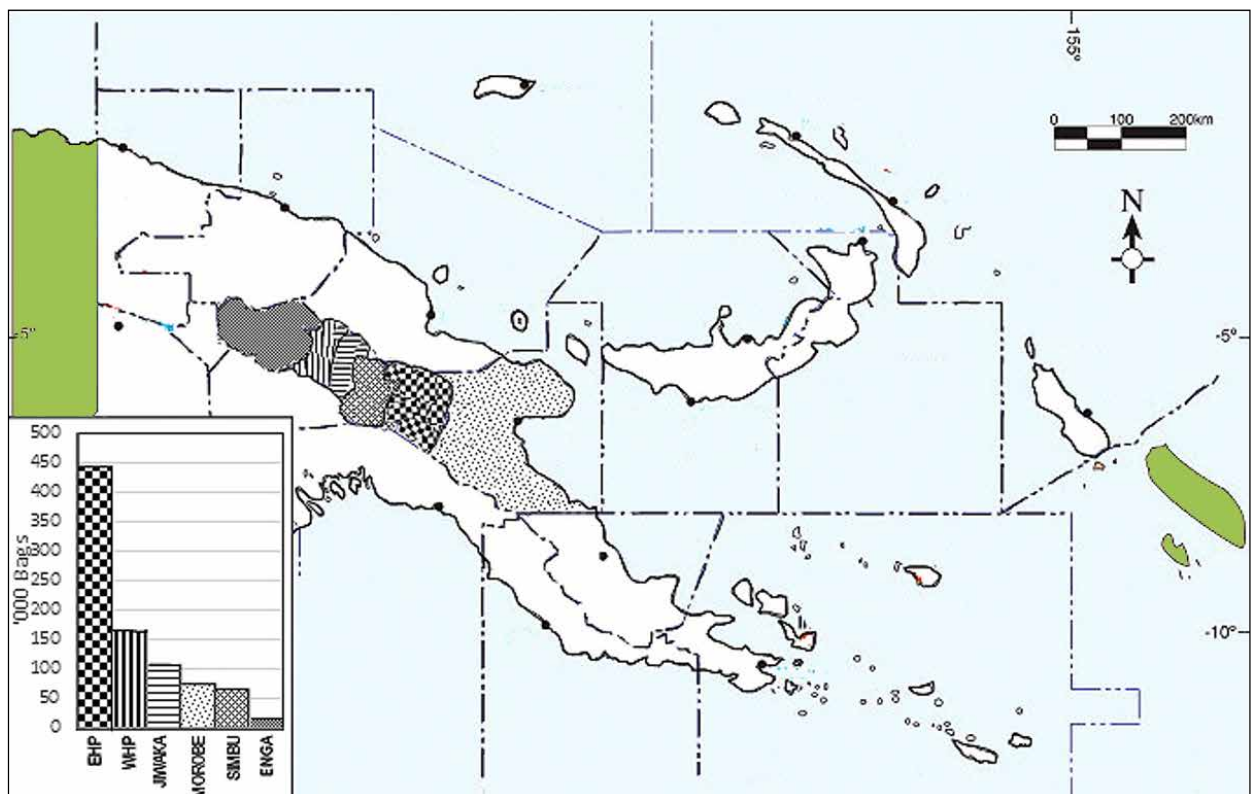
- For every bag of coffee that PNG produces, Vietnam produces 42 bags and Brazil 93 bags
- PNG is a small producer so rises and falls in PNG production have no effect on world price
- When Brazil has a frost, the world supply of coffee falls; the price of coffee worldwide increases and PNG farmers benefit



Arabica coffee (*Coffea arabica*)
Robusta coffee (*Coffea canephora* var. *robusta*)

Coffee in PNG

- Coffee was introduced into PNG in the late 1800s by the colonial administrations and missionaries. It was initially grown in lowland provinces including Central, Morobe, Oro, East New Britain and Bougainville
- Coffee production expanded significantly in the 1950s with the introduction of Arabica varieties in the highlands. Arabica coffee was grown in this region as the soil, altitude and climatic conditions were more suitable for Arabica varieties
- Arabica coffee always fetched a higher price than Robusta so production of Arabica expanded significantly more than Robusta as a result
- Robusta grows best in hot, humid, low-altitude areas. It is of poorer quality than Arabica and hence commands a lower price
- 95% of PNG coffee is Arabica
- The highlands region became and still remains the main production area for coffee in PNG. The provinces producing most of the coffee are Eastern Highlands, Western Highlands, Jiwaka, Morobe and Simbu

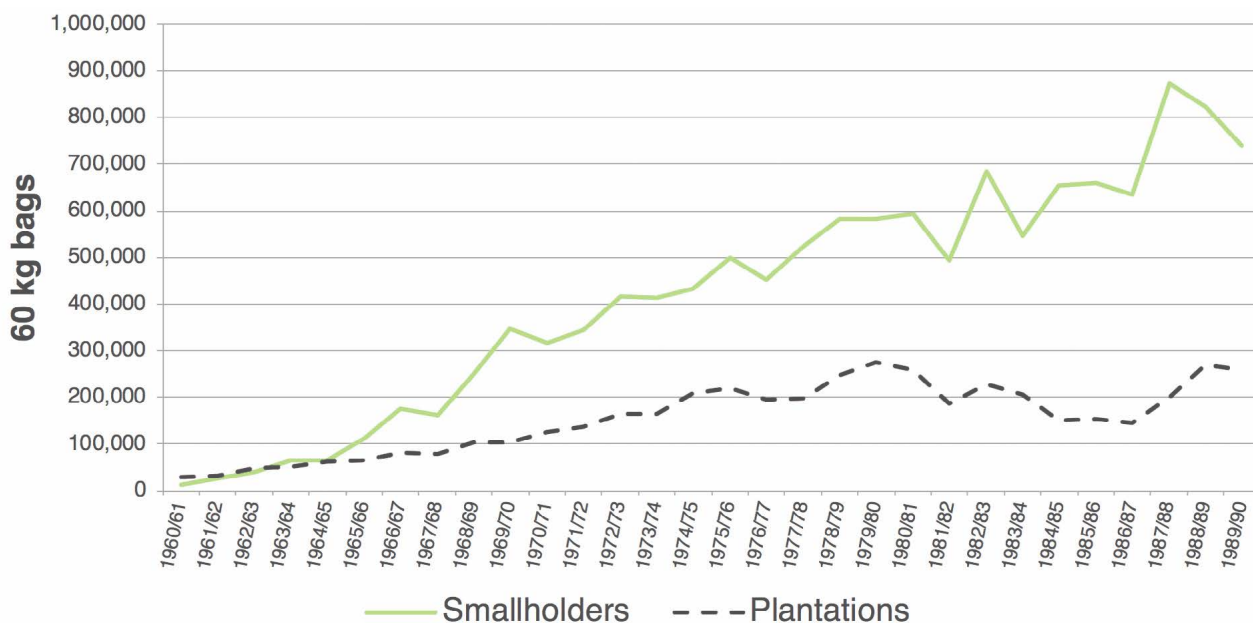


The main coffee producing provinces in PNG (CIC, 2018). (ANU Online maps)



Smallholder production of coffee follows a low-input system. Extension should be directed towards low-cost, minimal-labour input production strategies

- In the early 1950s production in the highlands was mostly on plantations but by the late 1950s there was a large expansion of smallholder coffee. This occurred as a result of increased extension training, an opportunity to earn cash income, high coffee prices and the building of the Highlands Highway. The plantations provided advice and a market link for smallholders
- The plantations went into decline in the 1980s and most were returned to customary land owners and were subdivided to become smallholdings
- Currently about 90% of PNG’s production comes from smallholders
- The main consumers of PNG coffee are the USA and Germany



Coffee production by smallholders and plantations from 1960/61 to 1989/90
 (Source: Data from Sengere 2016: 83-84)

1.2 COFFEE VARIETIES



Use the large CIC coffee varieties poster when describing the common varieties grown in PNG

Commercial coffee varieties in PNG

A number of commercial varieties of Arabica coffee are grown in PNG. The common varieties include:

1) Typica (or Blue Mountain var. Typica)

It is from Jamaica and is the world's oldest coffee variety and the first identified variety grown in PNG

2) Bourbon

It is from East Africa and is also one of the original varieties grown in PNG

3) Arusha

A selection from Bourbon that yields well in PNG

4) Mundo Novo

A cross between Typica and Bourbon

5) Caturra

A naturally occurring mutation, or change in the genes, of Bourbon, discovered on a plantation in Brazil. The mutation causes the plant to remain small and compact making it a dwarf variety

6) Catimor

A hybrid or cross between Arabica and Robusta

- Each variety has different characteristics in terms of hardiness, tolerance of pests and diseases and required labour inputs. These characteristics are considered in relation to the environment in which they will be grown
- Farmers should consider very carefully the requirements of each coffee variety, especially the labour inputs required to maintain healthy and productive trees

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Under the low-input conditions of most smallholders, yields that can be attained in plantations are unlikely to be met.

Note: Adequate shade levels will protect all varieties from the effects of drought.



Some factors to consider when choosing coffee varieties

- Drought resistant varieties (e.g. Typica) should be considered in areas having long dry seasons
- Coffee leaf rust resilient varieties (e.g. Catimor) should be grown in areas where this disease is prevalent but should be planted at low density under shade
- Some varieties (e.g. Caturra and Catimor) require high inputs of labour and fertiliser and so are more suited to plantation production, or for smallholders following methods of high input farming
- The varieties are either tall or dwarf but smallholders tend to prefer the tall varieties as they are hardier and more robust, and more tolerant of lower levels of farm management
- Taller varieties are easier to harvest. There is more space around the trees and harvesters do not need to bend over to harvest because they bend the branches downward to pick them
- Taller varieties with greater spacing are easier to maintain which is a very important consideration for CBB sanitation



Dwarf coffee variety - 'Caturra'



Tall coffee variety - 'Typica'



Arabica coffee varieties

Variety	Height	Colour of young leaves/growing tips	Hardiness	Pest & disease susceptibility	Ideal altitude (masl)	Labour Input requirements	Drought Resistant	Other considerations
Typica:	Tall	Brown	Hardy	Susceptible to CLR	800-1700	Low	Yes	One of the preferred varieties for smallholders in areas where CLR is not prevalent. Level of management inputs required: Low-Medium
Bourbon:	Tall	Green	Not as hardy as Typica	Susceptible to CLR	800-1700	Medium		Level of management inputs required: Medium
Arusha:	Tall	Bronze	Not as hardy as Typica		800-1700	Medium	Yes	Level of management inputs required: Medium
Mundo Novo:	Tall	Green	Not as hardy as Typica	Susceptible to CLR and Pink disease	800-1700	Medium		One of the preferred varieties for smallholders in areas where CLR is not prevalent. Smaller bean size. Level of management inputs required: Medium
Caturra:	Dwarf	Green	Not hardy	Not resistant to CLR	400-1500	High		Not recommended in areas where CLR is a serious problem. Level of management inputs required: High
Catimor:	Semi Dwarf	Bronze and Green	Not hardy	CLR tolerant	400-1500	High		Recommended in areas where CLR is a serious problem. Level of management inputs required: High

**Objective:**

To brainstorm different coffee varieties and their suitability to the local environment.

You will need:

CIC coffee varieties poster.

EXERCISE 1

Coffee varieties

Step 1:

Compare and discuss with farmers the different varieties of Arabica coffee cultivated in PNG.

Step 2:

Identify the coffee varieties commonly cultivated by smallholders in coffee gardens in the local area.

Step 3:

Discuss the suitability of coffee varieties in the area. Refer to the coffee varieties table above and the CIC poster of coffee varieties.

You may consider factors such as the following:

- Level of management inputs required
- Hardiness, resistance to drought, pests and diseases

1.3 STRUCTURE OF THE COFFEE TREE



Morphology of the tree is the study of its structure and growth behaviour



Structure of the coffee tree

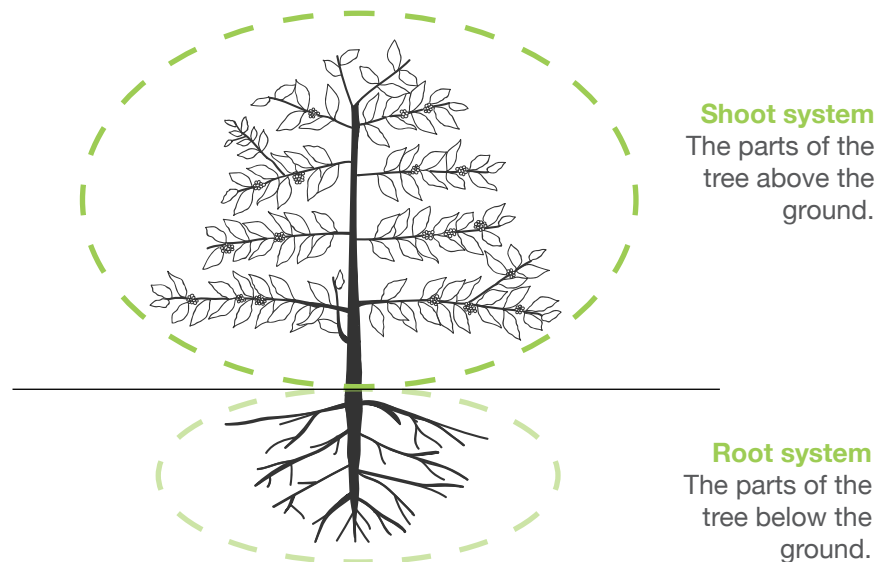
Why is it important to know about the structure of the coffee tree?

Understanding the structure of the tree and how it grows will help farmers to:

- Assess the health of trees
- Prune and care for trees correctly
- Identify productive and non-productive branches
- Know when is the best time to harvest
- Ultimately produce more and better quality coffee

The coffee tree can be divided into two main parts:

1. The shoot system
2. The root system



The coffee tree shoot and root system



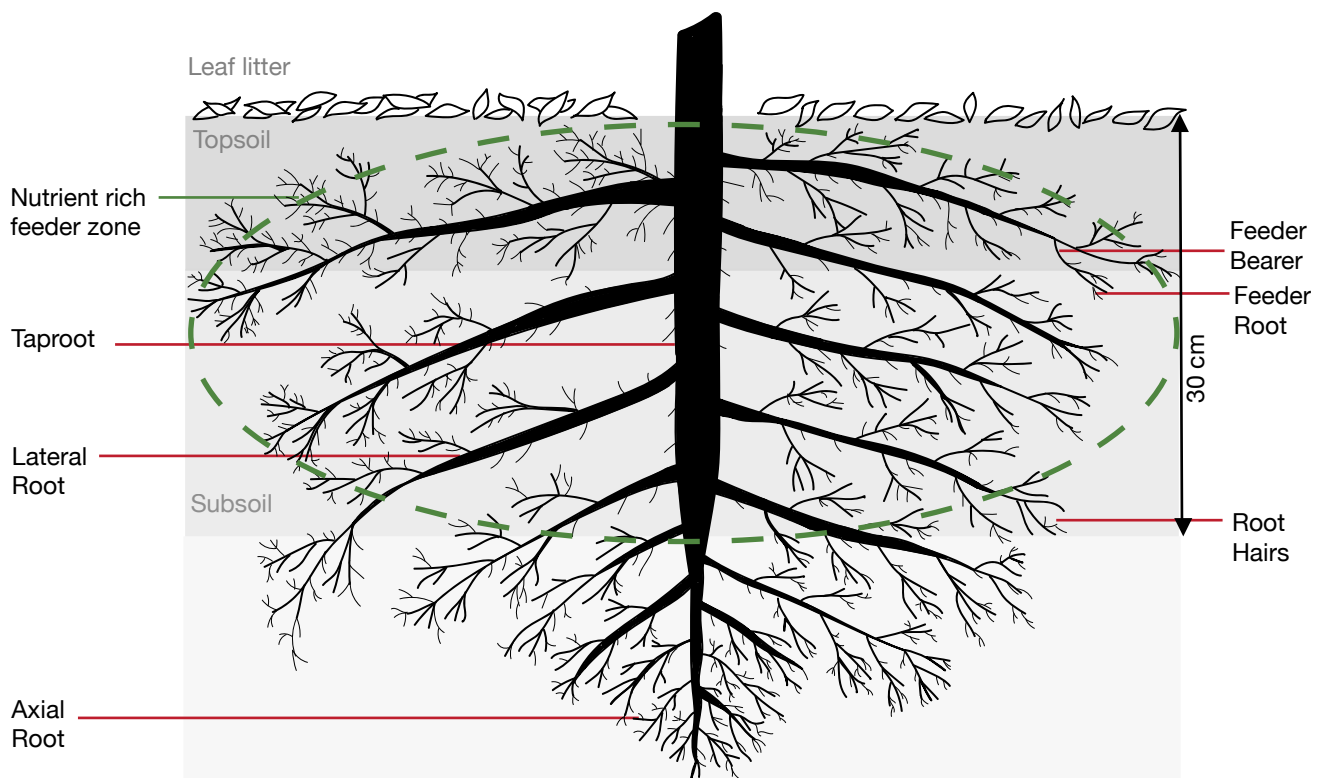
Use a young coffee tree with the roots exposed to demonstrate the structure of the root system

The root system

The root system has three main functions:

1. To hold the tree in place in the ground
2. Take up water and nutrients from the soil
3. Storage and transport of water and nutrients up to the shoot system

The three main types of roots on a coffee tree are the **taproot**, **axial roots** and **lateral roots**. From these grow **feeder bearers** and **feeders**. **Root hairs** grow on the feeders. Most (80%) of the roots are located in the top 30 cm of soil.



Coffee tree root system



Coffee tree root system

The **Taproot** is the main thick root that grows in a downward direction and holds the coffee tree in place. The taproot grows about 60 cm deep and can sometimes separate into multiple taproots. From the taproot the smaller axial and lateral roots grow.

Axial Roots come off the taproot in a horizontal direction and then grow in a downward direction penetrating up to 1 m deep. There are usually around 4-8 axial roots.

Lateral Roots grow in a horizontal direction out of the taproot sometimes as far as 1.8 m. **Coffee trees can be much wider below the ground than they are above the ground.** Most lateral roots are near the surface where the soil is nutrient rich (topsoil), although, they can grow at deeper levels where they tend to grow in a more downward direction.

Feeder Bearers grow out of the tap, axial, and lateral roots usually at about a 25 mm spacing. Near the surface of the soil, where there are more nutrients, they become shorter and are in greater number.

Feeders grow off the feeder bearer roots. Most are near the soil surface but they can be found at all depths. Root hairs are found on the feeder roots.

Root hairs grow from the feeder roots. They are found at all depths but are concentrated around the soil surface. Most of the coffee plant's nutrition is provided by the root hairs. Root hairs are very delicate and easily damaged by foraging pigs.

Maintaining healthy roots

- Healthy roots are essential for maximising production from your coffee trees
- Avoid planting coffee seedlings with bent taproots because when they mature they have less capacity to take up nutrients, shortening their productive lifespan
- Avoid too much disturbance of the soil as this can affect the uptake of nutrients by the roots
- The root mass near the surface is sensitive to weather variations (temperature and moisture). Mulch can be used as protection to maintain humidity as well as provide nutrients to the coffee plant. Mulch also improves the soil structure, enabling the roots to take up nutrients into the coffee plant. It can be placed around the tree out to the dripline but must not touch the tree stem, otherwise it will damage/burn the bark

Note: Mulching is not necessary if there is sufficient leaf litter provided by shade trees, such as Yar



Foraging pigs should be kept out of the coffee garden to prevent damage to the coffee tree roots

PREVENTING DAMAGE TO COFFEE TREE ROOTS

Most of the roots of a coffee tree develop in the upper 30 cm of the soil

Pigs digging in coffee gardens can cause a lot of root damage and reduce production.

If growing intercrops, plant them far enough away from the coffee trees so that:

1. You do not damage the coffee tree roots when digging to plant seedlings or when harvesting food crops.
2. The intercrop doesn't prevent development of a strong coffee tree root system.

Do not intercrop kaukau, tapiok, taro or yam as these will damage the coffee tree roots and may introduce pests.



Pigs digging and damaging coffee tree roots

Summary

- Most of the coffee tree's roots are in the nutrient rich topsoil
- It is mostly from this nutrient rich layer that the coffee tree obtains moisture and many of the nutrients required for plant growth and cherry development
- The roots can spread well beyond the dripline of the coffee tree so care must be taken not to damage the roots when digging in the coffee garden
- Apply mulch around the coffee tree out to the dripline to improve the soil structure and keep the roots healthy. If the roots are healthy they can access moisture and nutrients from the soil and move them up into the tree. Application of mulch is not necessary if shade trees provide sufficient leaf litter



Use the polybag coffee seedling and the one year old coffee tree to show the structure of the shoot system

The shoot system

The shoot system is made up of the **stem, branches, leaves, flowers** and **fruit** (or berries). **Stems** and **branches** provide the framework for the tree and are the main structures from which leaves, flowers, and fruit grow.

The **stem**, or trunk, is the main structural support or skeleton of the coffee tree arising vertically above ground. It supports all of the branches.

Branches contain **nodes** from which leaves, buds, more branches and flowers emerge. Branches can be erect (e.g. Mundo Novo) or horizontal (e.g. Typica) in form.



Typica (horizontal branching)



Mundo Novo (erect branching)



Photosynthesis occurs in the leaves. By absorbing light energy from the sun the tree converts carbon dioxide (from the air) and water (from the soil) into carbohydrates which are essential for plant growth

Internodes are the spaces between the nodes. The length of internodes can vary depending on the coffee variety and the amount of shade cover. The more shade cover the greater the length of the internodes.

In the young seedling, pairs of opposite leaves grow on the main stem from **nodes**. **Axillary buds** form in the axils of the leaves. Primary branches grow from the top most axillary buds. The remaining buds stay dormant or develop into suckers.

Buds, found in the leaf axils on primary branches, develop into flowers, leaves & secondary branches.

Fruit or berries develop from fertilised flowers. Each fruit usually contains two **seeds** or beans.

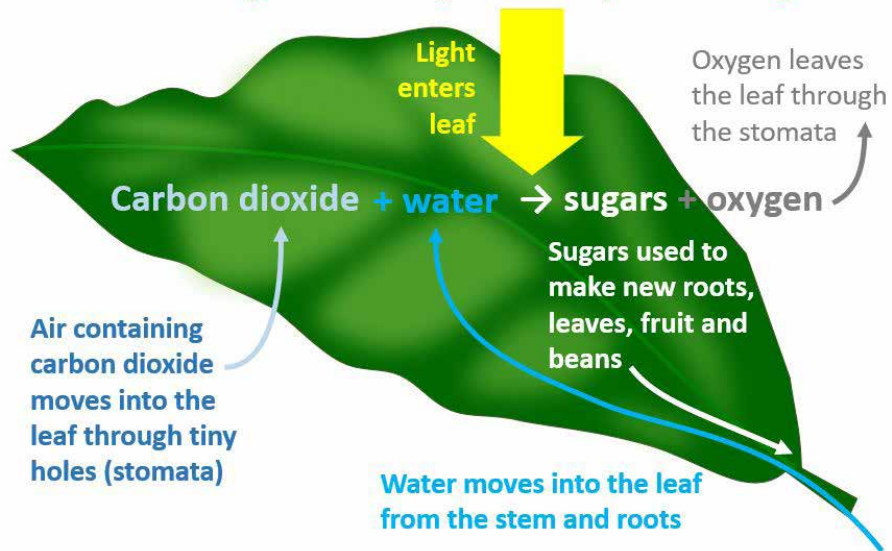
Leaves are like solar panels collecting energy from the sun. This powers the plant to produce its own food by the process of photosynthesis. The leaves vary in size, shape and colour depending on the variety. The size and colour is also influenced by age, location on the plant, the season, nutrition and level of shade.



Use PowerPoint animation of photosynthesis

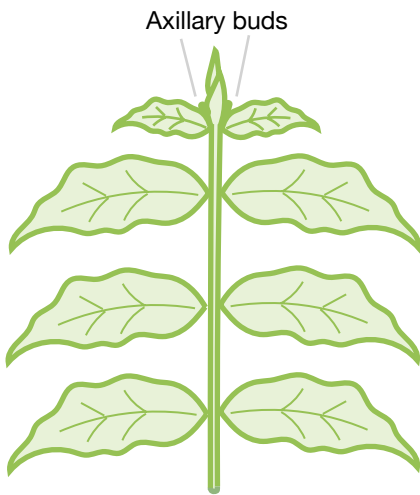
Photosynthesis

Is the creation of sugars in leaves using carbon dioxide, water and sunlight

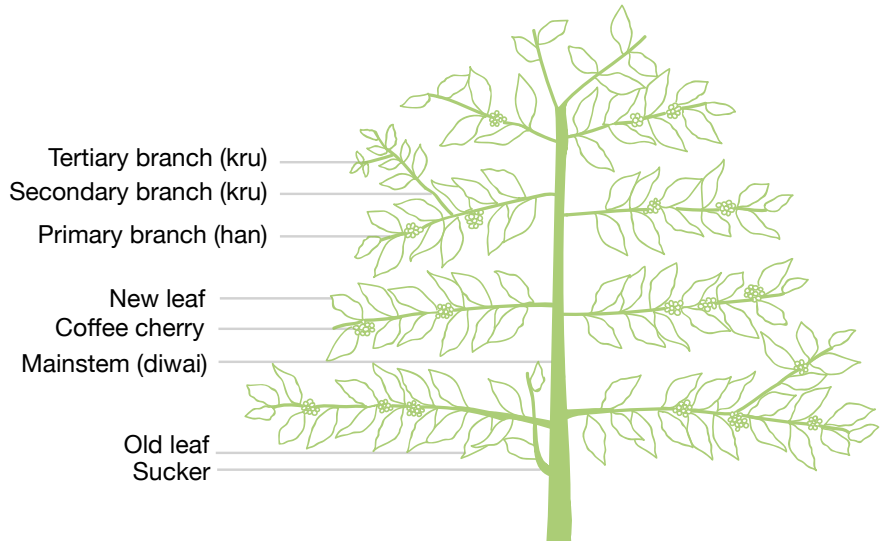


Credit: Paul Nelson

Suckers grow only on the main stem. They should be removed so that they don't take valuable nutrients from the tree. When the primary branches age they will be cut down and productive suckers will be left to grow and replace the old primary branches. This is called recycle pruning (*Refer to the Farmer Training Guide Unit 2 Module 2: Maintenance, pruning and rehabilitation for further information*).



The shoot system of a young coffee seedling



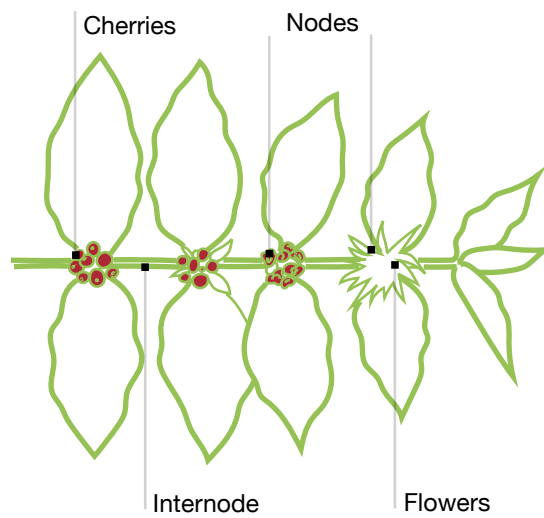
The shoot system of a coffee tree



Coffee tree shoot system



Occasionally, only a single seed develops in the fruit; this is known as a pea berry. Pea berries command a higher price



INTERNODES

The length of internodes differs between varieties, but it is also influenced by environmental conditions like shade levels.

Trees with shorter internodes and therefore more nodes on each branch tend to produce more cherries.

BUT

Trees with tightly bunched nodes can also be more difficult to harvest. This can be a problem with dwarf varieties.

Tall varieties with optimum shade cover will have internodes at a distance which makes harvesting easier compared with dwarf varieties with short internodes.

Easier harvesting enables more effective control of CBB

Summary

- The shoot system is made up of the stems, branches, leaves, flowers and fruit
- The stem provides structural support for the tree, and the primary branches produce the buds which develop into secondary branches, leaves, flowers and fruit
- The powerhouse of the coffee tree is in the leaves as this is where the plant makes its own food
- It is very important to keep the shoot system healthy so that the tree can make its own food and move the food around the tree. The food helps the tree grow and produce many flowers and fruit
- Many flowers and fruit mean more money

Competition and the importance of maintaining a healthy shoot and root system

The root system, or the parts of the coffee tree below the ground, compete with other plants for moisture, nutrients and space. Likewise, the shoot system, or the parts of the tree above the ground, compete for light and space.

Competition, both below and above ground, can be with other coffee trees, weeds, shade trees or intercrops.

It is important to minimise competition in order to maintain healthy growth of all coffee trees in the coffee garden. This can be achieved by the following:

- Plant coffee varieties recommended for smallholders in your area
- Use the recommended coffee tree and shade tree spacings for smallholders
- Minimise weed growth
 - When the coffee trees are young apply mulch, such as coffee pulp
 - As they mature, appropriate permanent shade trees, planted at the correct spacing, will provide shade and leaf litter to suppress weeds
- Use deep rooted, nitrogen fixing shade tree species. The roots of the shade trees will grow deeper into the soil than those of the coffee trees so will have little impact on coffee tree root growth. Nutrients and moisture closer to the soil surface will remain available for the coffee trees and the shade trees will have the added advantage of providing supplementary nitrogen for the coffee trees. Shade trees must be well maintained to ensure the coffee trees have access to sufficient light
- Intercrops can be grown between the coffee trees, particularly when the coffee trees are young. Grow only crops that will not compete with the coffee trees for space, light, moisture and nutrients (*see the Farmer Training Guide Unit 2 Module 8: Intercropping in your coffee garden for more information*)

Objective:

To observe, identify and discuss the functions of various parts of a coffee tree with farmers in a coffee garden.

You will need:

To be in a coffee garden (or have a diagram of a coffee tree). After discussing the parts of the shoot system, dig up a small tree and discuss the parts of the root system.



EXERCISE 2

Parts of a coffee tree

- Identify parts of the coffee tree
- Discuss the functions of each part
- Discuss:
 1. Where flowers emerge on the tree
 2. Where suckers emerge on the tree
 3. The different types of roots and their functions

Objective:

To discuss the main factors that contribute to producing and maintaining a healthy shoot and root system.

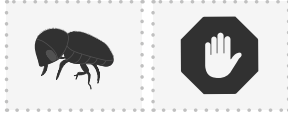


EXERCISE 3

The importance of maintaining healthy roots and shoots.

- Discuss plant spacing of coffee trees and shade trees in relation to competition for space, moisture, nutrients and light.
- Why is it important to control weeds? How can they be controlled? Discuss the use of shade trees and mulch.
- It is important to plant deep rooted shade trees that fix nitrogen (e.g. Yar and Marmar). Why?

1.4 DEVELOPMENT OF COFFEE CHERRY

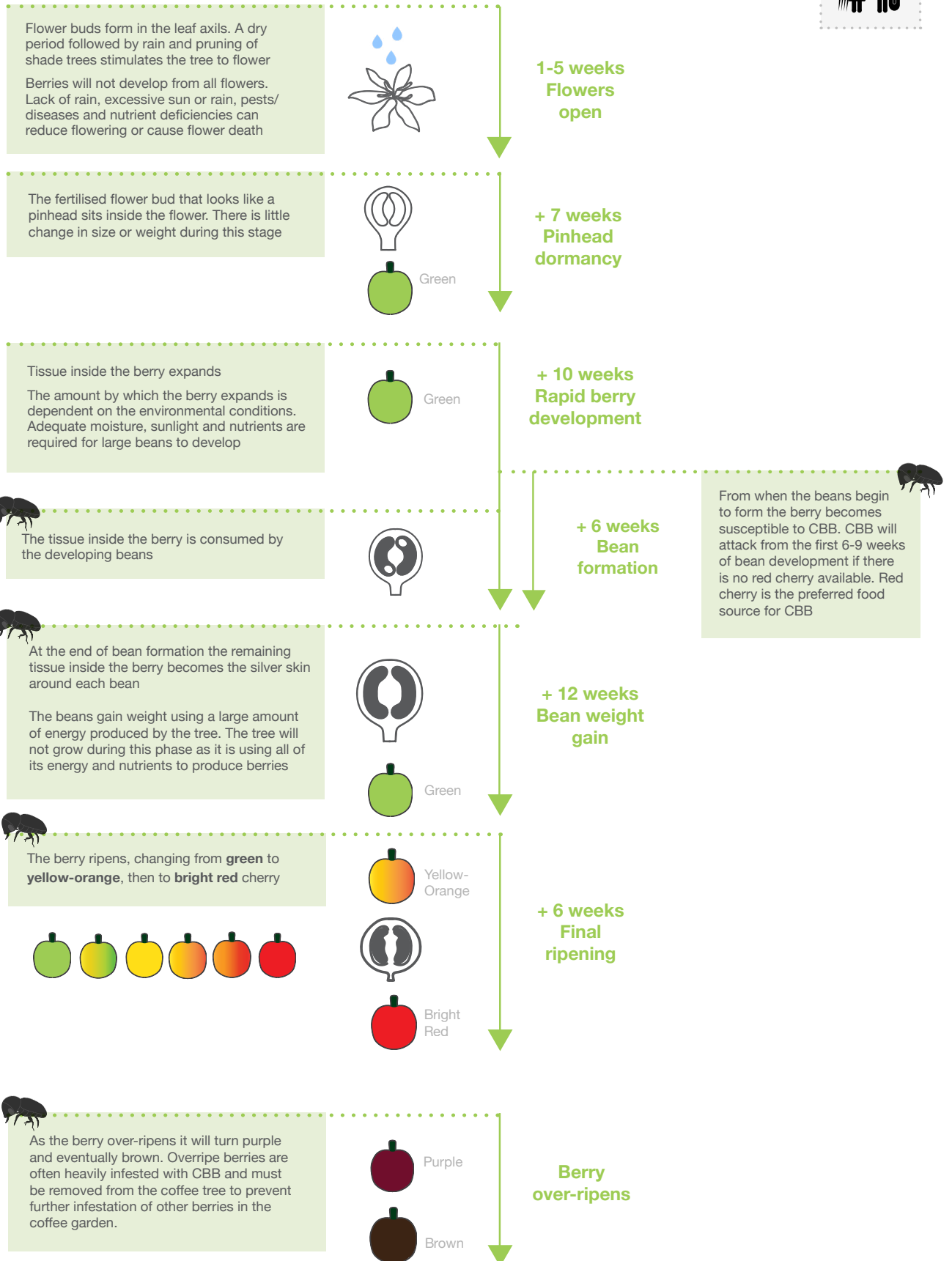


Overripe cherry and old raisins can contain a lot of CBB

Flowering to harvest

- Coffee cherry takes nine to ten months to develop from flowering through to when the bright red cherries are ready to harvest
- Rain following a dry period will stimulate flowering, so in PNG most flowering occurs at the start of the wet season
- Shade pruning just before flowering will increase flower production
- The flowers will mostly self-pollinate and then the fertilised flower bud will stay at the pinhead stage for almost 2 months before it begins a rapid growth phase producing the berry. During this time the beans will also begin to form
- The beans increase in size and weight over the next 3 months
- Both the beans and berry ripen over the last 6 weeks and will then be ready for harvest
- In the final ripening period the berry changes colour. At first it is green, then gradually changes to yellow-orange and then to bright red cherry. It gets heavier and sweeter as it ripens and will be at its maximum weight and value when bright red. This is the best time to harvest to maximise profit
- If the cherry is left on the tree for too long and over-ripens it turns brown and is then too old and sour, and loses value
- The average annual yield of cherry from a typical smallholder tree is 1 kg. The maximum yield from a coffee tree in a very well managed plantation, with fertiliser applied, is 6 kg per tree

Development of coffee cherry from flowering to harvest:





Cherry Development

1. Use the coffee bean development poster
2. Show a branch of a coffee tree with progressive colours of ripening berries. Point out the ripe, bright red cherry that is the most valuable
3. Use 4 bowls of berries with each bowl containing berries at different stages of development, including green, yellow-orange, bright red and brown

When to harvest cherry

- Cherries are at peak weight, quality and value when **bright red**
- More weight and better quality means more money



Bright red cherries ready for harvest

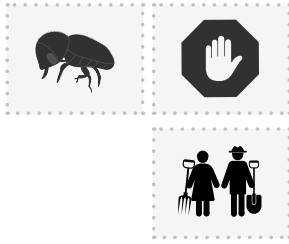


- A measure used to control CBB when harvesting is to pick all red, black and overripe berries **every 1-2 weeks**. Only green, yellow and orange berries should be left on the coffee trees



Berries that should be picked during a normal harvesting round in a CBB environment (Source: Big Island Coffee Roasters).

- At the final harvest all berries should be removed. Alternatively, farmers wanting to harvest year round, or for extended seasons can leave green berries on the trees and strip pick all other berries



ALL-YEAR FLOWERING AND CBB

- Further flowering after the main flowering period is common due to intermittent dry and rainy periods, and also too little shade
- All-year flowering has the potential to encourage CBB. Having flowers constantly present means berries are always forming on the tree. These are hosts for CBB providing the pest with a continuous food supply and a place to breed
- Avoiding all-year flowering by providing appropriate shade and removing off-season flowers will help break the pest's life cycle
- Maintenance pruning will remove unwanted secondary branches and reduce competition for space, light and nutrients. This will also mean there are less sites for CBB infestation (*see the Farmer Training Guide Unit 2 Module 2: Maintenance, pruning and rehabilitation for more information*)
- Shade can be used to regulate flowering and CBB infestation levels. When shade levels are optimum, flowering and fruiting are more synchronised. This means more trees are likely to flower and fruit at a similar time making the control period for CBB more manageable (*see the Farmer Training Guide Unit 2 Module 3: Shade management for further information*)
- If flowering is more synchronised, strip picking at the end of harvest will be more effective as a CBB control measure. Few berries will be present throughout the remainder of the year
- If appropriate shade is not applied and all-year flowering occurs, continual harvesting of berries will be required throughout the year to control CBB



The fully developed coffee cherry

Parts of the fully developed coffee cherry

When the fruit or cherry is fully developed the beans are surrounded by a number of layers. While still on-farm and prior to sending to the mill, the skin, pulp and mucilage are removed from the cherry. At the mill the parchment and silver skin are removed with the end product being the naked beans.

ON-FARM PROCESSING

MILL PROCESSING

1. Skin
Removed by pulper

2. Pulp
Removed by pulper

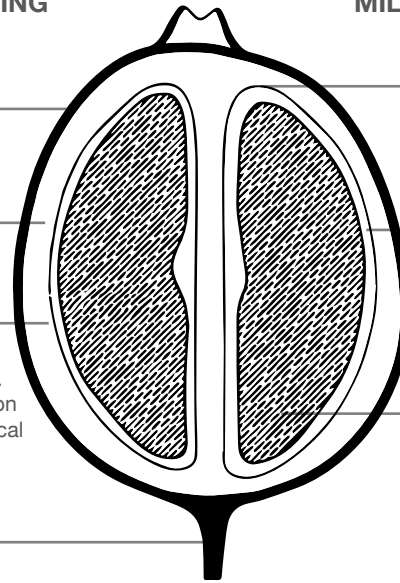
3. Mucilage
Is the greasy layer surrounding the parchment. It is removed by fermentation & washing or by a mechanical demucilager

4. Stalk

5. Parchment
Covers the silver skin & is removed by hulling.

6. Silver skin
Is a membrane surrounding the bean. Removed by hulling & polishing.


7. Bean



A fully developed Cherry

Summary

Note: Now that you understand the structure of the coffee tree and its development, the Coffee Calendar can be used to plan your activities in line with the coffee cycle. This will enable you to achieve high yields from your coffee trees.

- When rain falls after an extended dry period, the coffee trees will flower and a pinhead will form which is the beginning of the development of a berry
- After about 12 weeks the berries will begin a rapid phase of expansion and during this time the beans will begin to form
-  It is during the phase of bean formation that the berries become susceptible to CBB
- The growth of large, healthy berries is dependent on adequate moisture, sunlight and nutrients
- As the berries mature they will change in colour from green to yellow-orange and finally to bright red cherry. This is when they are most valuable
- The cherry will be processed on the farm and at the mill to produce the end product for sale to consumers which are the naked beans

Objective:

To discuss cherry development and observe the different phases of development

You will need:

4 bowls of berries at different stages of development (green, yellow-orange, bright red, brown)

EXERCISE 4



Cherry development

Coffee cherry takes 9-10 months to develop from flowering through to when the bright red berries are ready to harvest.

- Discuss with farmers how they harvest. Ask them about the type of berries they pick. Most often the berries picked are a mixture of semi ripe to fully ripe
- Explain that in a CBB environment it is important to harvest all berries, except green, yellow and orange. Overripe berries can be separated when processing
- Display bowls of berries showing the different stages of ripening. Have the farmers point out those that are most valuable. Compare the weight of the bright red ripe cherries with those that are under or overripe

Objective:

Identify the parts of a fully developed coffee cherry and describe how each part is removed.

You will need:

The diagram displayed.

EXERCISE 5

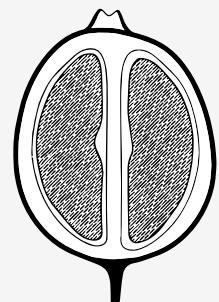


Parts of the coffee cherry

Label each part of the cherry

Discuss:

- Which parts are removed during on-farm processing and how they are removed
- Which parts are removed during processing at the mill and how they are removed



1.5 KEY MESSAGES

What are the important messages for the farmer?

- PNG produces 1% of world coffee. Coffee prices in PNG are dependent on world coffee prices
- 95% of coffee produced in PNG is Arabica. The highlands is the main production area and the producers are mostly smallholder farmers
- The main varieties grown by smallholders are the tall varieties: Typica, Bourbon, Arusha and Mundo Novo
- Local environmental conditions, hardiness, tolerance of pests and diseases and required labour inputs are characteristics to be considered when choosing a suitable coffee variety to grow in your coffee garden
- The root system of the coffee tree provides support for the tree and absorbs water and nutrients from the soil which it then transports up to the shoots. Most roots are in the top 30 cm of the soil so they must be protected from damage by digging or foraging pigs
- The shoot system is made up of the stems and branches from where the leaves, flowers and berries grow. The leaves are very important components of the coffee tree as this is where the tree makes its own food. The food is transported around the tree in a transport system similar to how our food is transported around our bodies in blood vessels
- Coffee cherry development begins with flowering. When the berries begin to expand, the coffee tree uses a lot of energy and nutrients to produce large, bright red, healthy cherries. It is when the cherries are bright red that they are at their highest value
- All-year flowering creates ideal conditions for CBB. The risk of infestation or spread of CBB can be reduced by removing all off-season flowers, maintenance pruning and providing optimum shade
- It is important to keep the coffee tree roots, shoots and berries healthy in order to maximise income from your coffee garden



1.6 QUIZ

Place an '✓' in the correct box.

1. Who sets the coffee price?

- A United Nations
- B CIC
- C PNG government
- D Coffee exporters
- E World market based on the quantity for sale and the level of demand

2. Which is a common variety of Arabica coffee grown by smallholder farmers in PNG?

- A Typica
- B Arusha
- C Bourbon
- D Mundo Novo
- E All of the above

3. Choose the two coffee varieties that require high inputs of labour.

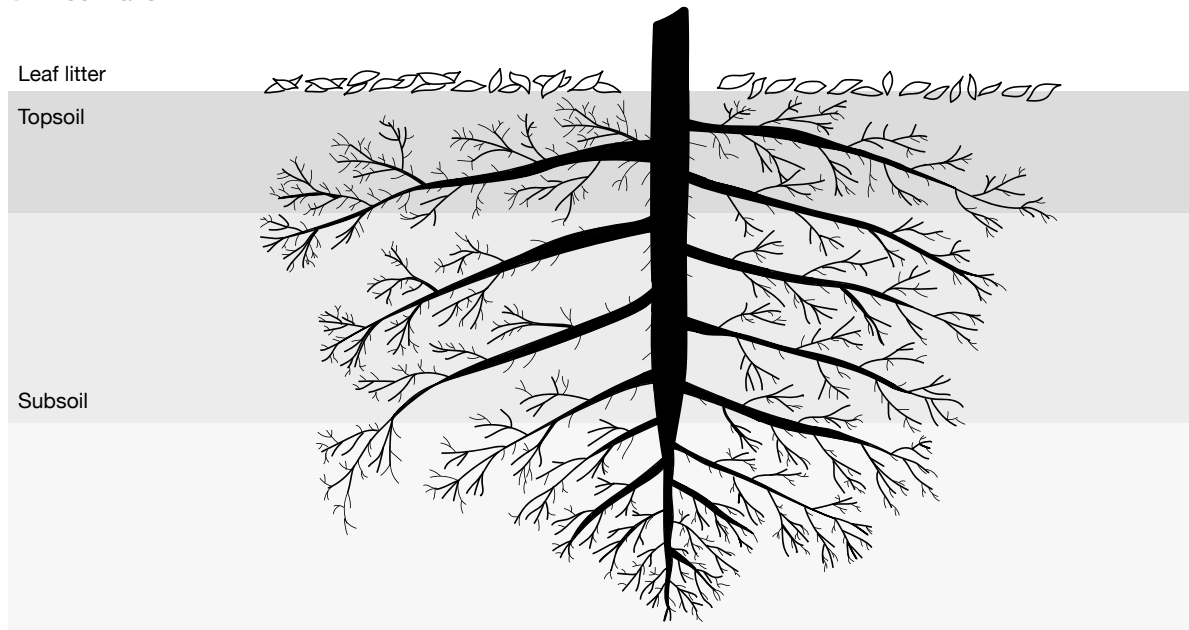
- A Catimor
- B Typica
- C Mundo Novo
- D Caturra

4. What are the three main functions of the coffee tree root system? (Tick all 3 that apply)

- A Make food for the coffee tree
- B Take up water and nutrients from the soil
- C Produce coffee cherry
- D Store and transport water and nutrients up to the shoot system
- E Produce primary branches
- F Hold the tree in place

5. Draw lines from the list of root types to the appropriate location on the diagram of the coffee tree root system.

- a. Taproot
- b. Lateral root
- c. Feeder bearer
- d. Feeder root
- e. Root hairs



6. Photosynthesis is the process whereby the coffee tree makes its own food using carbon dioxide from the air, water and sunlight. In which part of the tree does this take place?

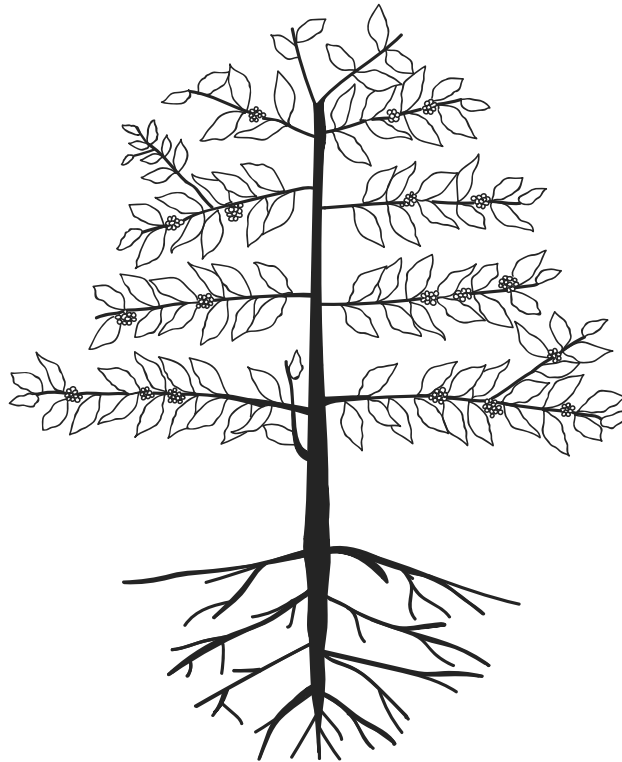
- A Stem
- B Roots
- C Cherries
- D Leaves
- E Flowers

7. Approximately how many months does it take for a coffee flower to develop into a bright red cherry ready for harvesting?

- A 2 months
- B 6 months
- C 9 months
- D 24 months

8. Label the diagram below drawing lines from the following list of plant parts to the appropriate location on the diagram of the coffee tree shoot system.

- a. Main stem
- b. Primary branch
- c. Secondary branch
- d. Leaf
- e. Berries
- f. Sucker

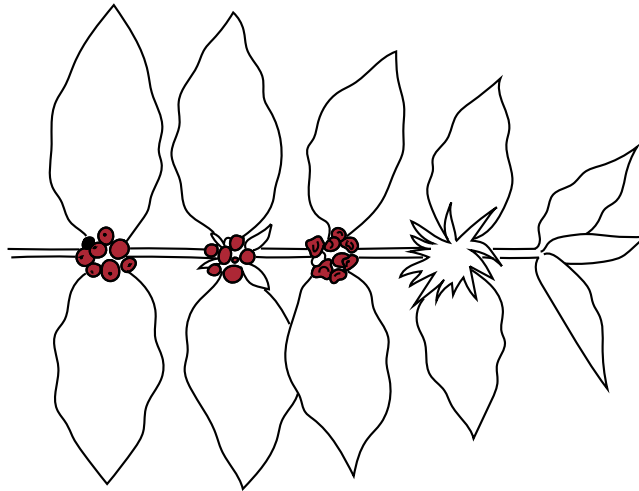


9. CBB may become a problem in coffee berries from as early as when the berries are green and the beans are beginning to form. At which stage of development would a berry be likely to contain the most CBB?

- A Pinhead
- B Green berry
- C Orange-yellow berry
- D Red cherry
- E Brown berry

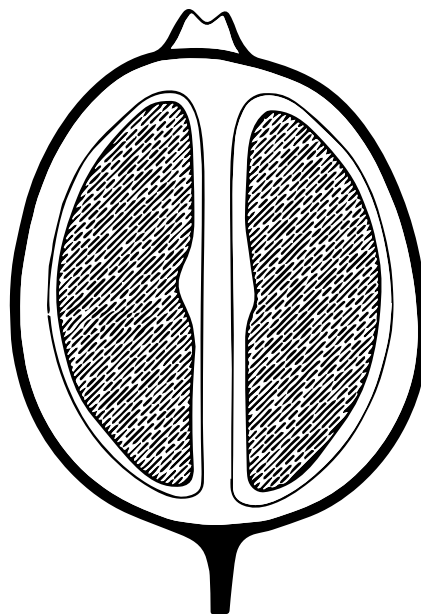
10. Label the following on the coffee branch below.

- a. Node
- b. Internode
- c. Coffee cherries



11. Label the following on the diagram of the fully developed coffee cherry below.

- a. Skin
- b. Pulp
- c. Mucilage
- d. Parchment
- e. Silver skin
- f. Bean



12. True or false.

	True	False
a. Tall varieties of coffee with the right amount of shade are easier to manage than dwarf varieties of coffee.	<input type="checkbox"/>	<input type="checkbox"/>
b. Allowing pigs to dig in the coffee garden is good for the roots of the coffee trees.	<input type="checkbox"/>	<input type="checkbox"/>
c. Most of the root system of a coffee tree is found in the top 30 cm of the soil.	<input type="checkbox"/>	<input type="checkbox"/>
d. Coffee trees with short internodes on the branches are easier to harvest than those with long internodes.	<input type="checkbox"/>	<input type="checkbox"/>
e. Further flowering after the main flowering period is common due to intermittent dry and rainy periods, as well as too little shade.	<input type="checkbox"/>	<input type="checkbox"/>
f. Shade cover makes internodes longer.	<input type="checkbox"/>	<input type="checkbox"/>
g. CBB only attacks the berries when they are bright red.	<input type="checkbox"/>	<input type="checkbox"/>
h. All coffee berries should be removed from the coffee garden at the final harvest to help prevent or control infestations of CBB. Underripe berries should only be left on the trees if farmers want to continue harvesting all-year or for extended seasons.	<input type="checkbox"/>	<input type="checkbox"/>

1.7 SOURCES OF FURTHER INFORMATION

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